STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY

DEPARTMENT OF TRANSPORTATION
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METHOD OF CALIBRATION OF COMPACTION TEST EQUIPMENT

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section E of this method. It is the responsibility of the user of this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed.

A. SCOPE

The procedure for calibration of both the California impact compaction apparatus and the sand volume apparatus are described in this method. The test equipment described in California Test 216 is used for determining test maximum density and in-place field density. This method is divided into the following parts:

1. Calibration of the Impact Compaction Apparatus.
2. Calibration of the Sand Volume Apparatus.

PART 1. CALIBRATION OF THE IMPACT COMPACTION APPARATUS

A. APPARATUS

1. Weighing scale of 5-kg capacity, sensitive to 1 g.
2. Variable diameter metal plug with rubber o-rings. See Figure 1.
3. Containers for pouring water: 200-mL and 5-L capacities.

FIGURE 1

4. Shatter resistant, flat, transparent nonpliable plate, 100 by 100 mm.
5. Water insoluble, heavy-duty grease.
6. Machinist's scale - minimum 1.00 m in length, 0.25-mm divisions or a dial indicator and stand. See Figure 2.

7. Calipers or micrometer with at least a 75-mm capacity, graduated to 0.25 mm.

8. Eye dropper.

9. A fixed depth "T" bar capable of measuring 305 ± 0.05 mm. See Figure 3.

10. Fixed-length, hooked bar for measuring 591.8 mm. See Figure 4.

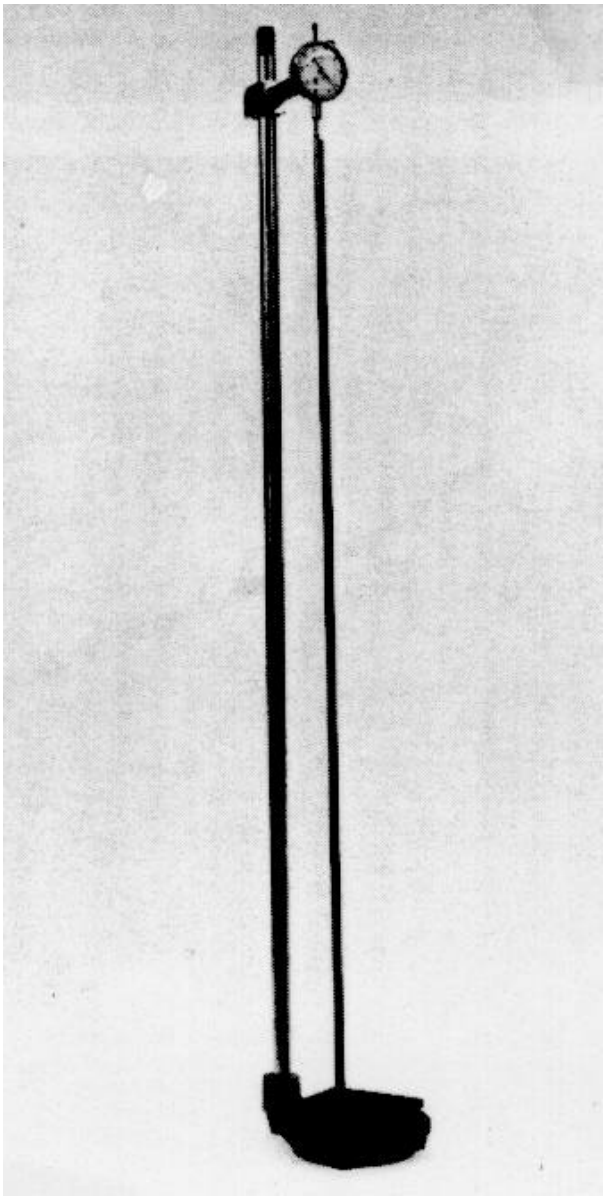

FIGURE 2

B. CALIBRATING PROCEDURE

1. Remove the baseplate and cap section from the mold. See Figure 5.

2. Examine joints and machined surfaces to ensure that they are smooth and will not show visible openings. Examine the clamps for missing bolts and/or wing nuts.

3. Place a thin bead of grease on the joint surfaces of the cap section. This grease bead seals the seam between the cap section and the mold when the mold is reassembled. A grease seal is also necessary around the metal plug to prevent water leakage.

4. Examine the mold to see if it is out of round. If the diameter is more than 1.0 mm out of round, the mold should not be calibrated and should be discarded.

5. Place the plug in the mold 305 ± 0.05 mm from the base of the mold by using the fixed depth "T" bar, as shown in Figure 6. The placement of the plug at 305 ± 0.05 mm depth is critical. Then replace the greased cap section on the mold proper, clamp in place, and clean excess grease from the inside of the mold.

6. Place the mold on end with the base facing upward. The 305 mm section to be calibrated is now in an upright position. Make a final check of the 305 mm depth setting of the plug and make sure that the clamps are finger-tight.

7. Fill the water containers with approximately 3000 g of water. Determine the mass of the water, containers, and eye dropper to the nearest gram. Record this gross initial mass on line (a) of the Calibration Record Form See Figure 7.

8. Grease the base of the mold and place the clear plate flat over the base so that about a 12.5-mm opening is left. See Figure 8. Carefully pour the 3000 g of

FIGURE 3

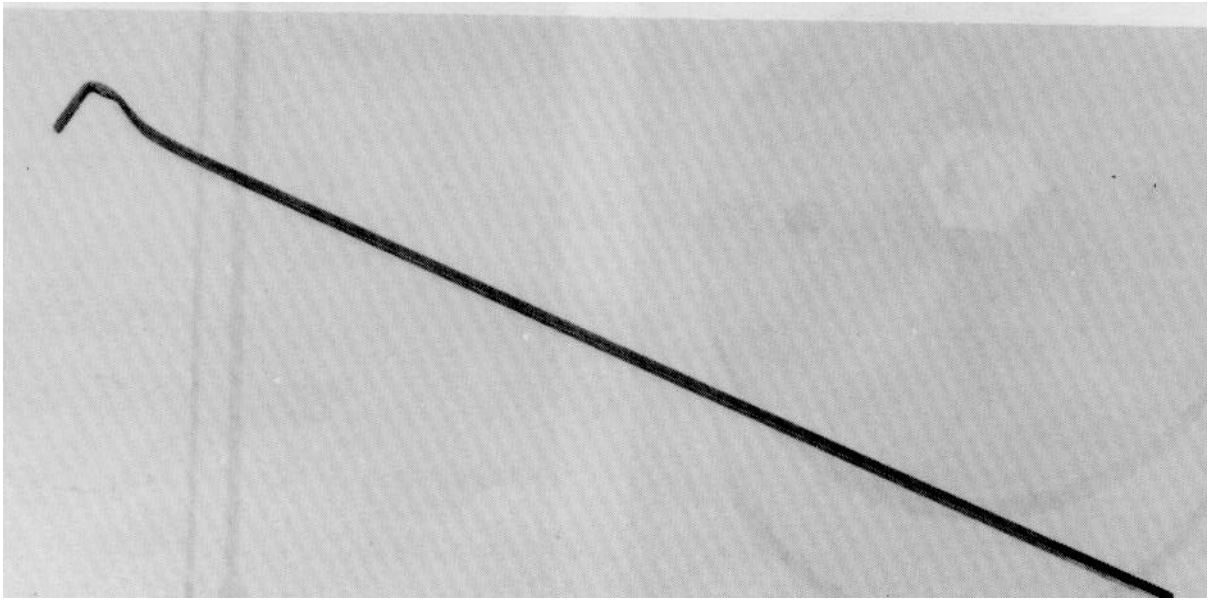

FIGURE 4

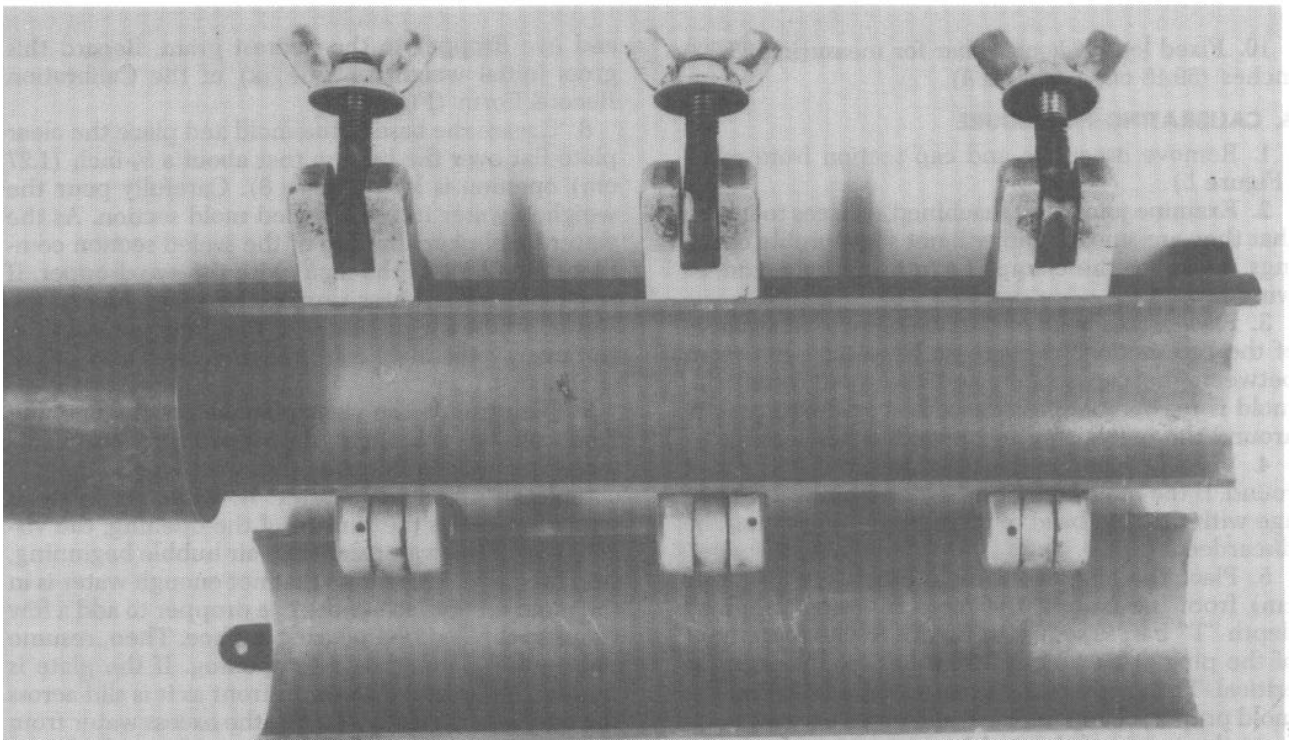

FIGURE 5

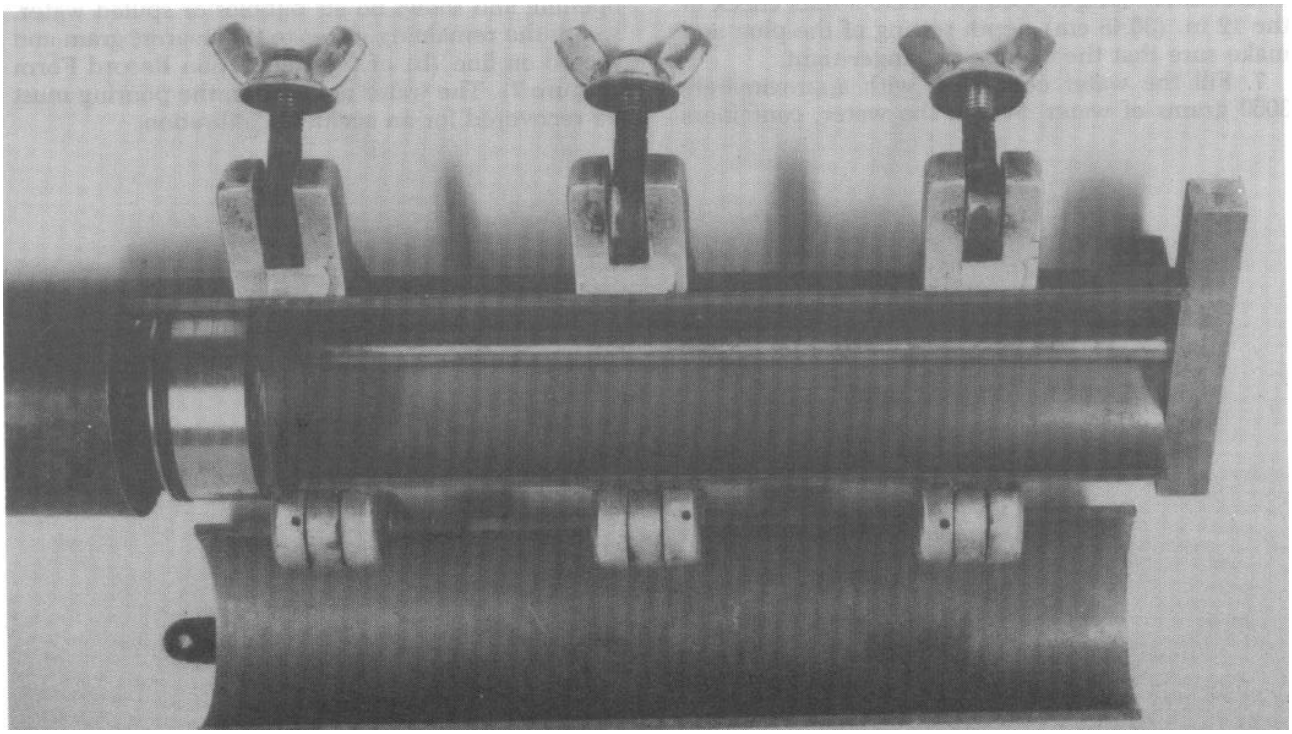

FIGURE 6

CALIFORNIA IMPACT COMPACTION TEST MOLD CALIBRATION RECORD

MOLD NO._____ DATE _____ DISTRICT_____ CALIBRATED BY _____

1. Volume of water to fill 305 mm of mold, in mL

	Trial 1	Trial 2	Trial 3
(a) Initial mass of water, in g	1500	1523	1497
(b) Remaining mass of water, in g	237	258	234
(c) Mass of water to fill mold (a-b), in g	1263	1265	1263

(d) Average mass of water, in g

$\frac{\text{Trial 1+2+3}}{3}$ = (Volume , in mL) 1263.8

2. Indicated Overall Mold Length from Conversion Chart (Figure 10), in mm 36.02

3. Measured Overall Mold Length , in mm 36.00

4. Length Difference (2-3) (Spec. Max . ± 1.0 mm of No. 2) , in mm -0.02

5. Length Condition Satisfactory X Long _____ Short _____

6. If out of specifications,

(a) How much to cut off, in mm N/A

(b) How much to build up, in mm N/A

Assessory Equipment		**Specifications**
Tamper Mass	_____ g	4536 ± 4.5 g
Tamper Length (Face to graduation mark "10")	_____ mm	591.8 ± 0.8 mm
Piston Length	_____ mm	68.6 ± 0.75 mm
Hooked Rod	_____ mm	457 ± 1.5 mm

FIGURE 7

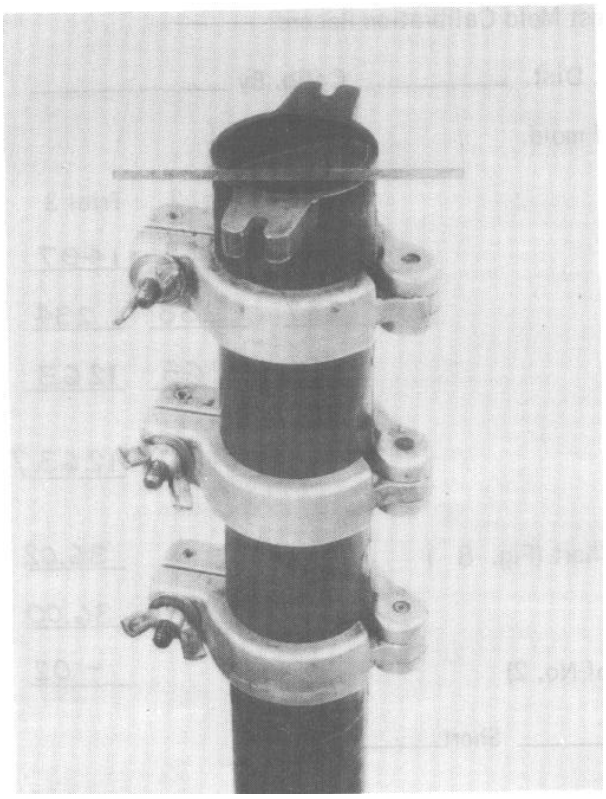

FIGURE 8

water into the sealed mold section. As the water level nears the top of the sealed section, complete the filling of the mold with the eye dropper. If the mold leaks water during the pour, empty the water, adjust the diameter of the plug, retighten the wing nuts and start the test over. If the mold continues to leak, it may be out of round.

9. Gently slide the clear plate across the opening while applying a slight downward pressure. This technique aids in determining whether the mold is completely filled with water. If, while the plate is being slid across the surface of the opening, the viscous seal of the water shows an air bubble beginning, stop the plate. This shows that not enough water is in the mold section, so use the eye dropper to add a few drops to the exposed pouring surface. Then, resume sliding the plate across the opening; If the plate is pushing an excess of water in front as it is slid across the opening, carefully remove the excess water from the opening with the eye dropper. Above all, do not spill or lose any of this water.

10. When the plate is slid completely across the opening and shows no air bubbles or spilled water, determine the mass of the remaining water to the nearest 1 g and record on line (b) of the Calibration Record Form. See Figure 7. The water not used in the pouring must be recovered for an accurate calibration.

11. The difference between the initial mass of water and the remaining mass of water, between 1250 and 1300 g, is also the volume of the measured section, in mL. Take three measurements and record these measurements on Line (c) of the Mold Calibration Record. See Figure 7. Record the average of these three measurements on line (d). Refer to the conversion table in Figure 10 for the mold length corresponding to the volume just measured, and record on Line 2 of Figure 7. This is the overall length of the mold excluding the baseplate.

12. Measure the present overall length of the mold with the 1-m machinist scale or with the dial indicator, Figure 2, and record on line 3 of Figure 7. The dial indicator is set to read 12.7 mm with the calibration rod and plate as shown in Figure 9. Determine the difference in length between Lines 2 and 3 and record on Line 4 of Figure 7. If the present measured length is within 0.5 mm of the indicated calibration length from Figure 10, no adjustment is necessary. If the mold is too long, the excess length must be machined down. If the mold is too short or distorted and out of round, the mold will have to be discarded. In some cases, a short mold can be built up by welding and machining to the proper length.

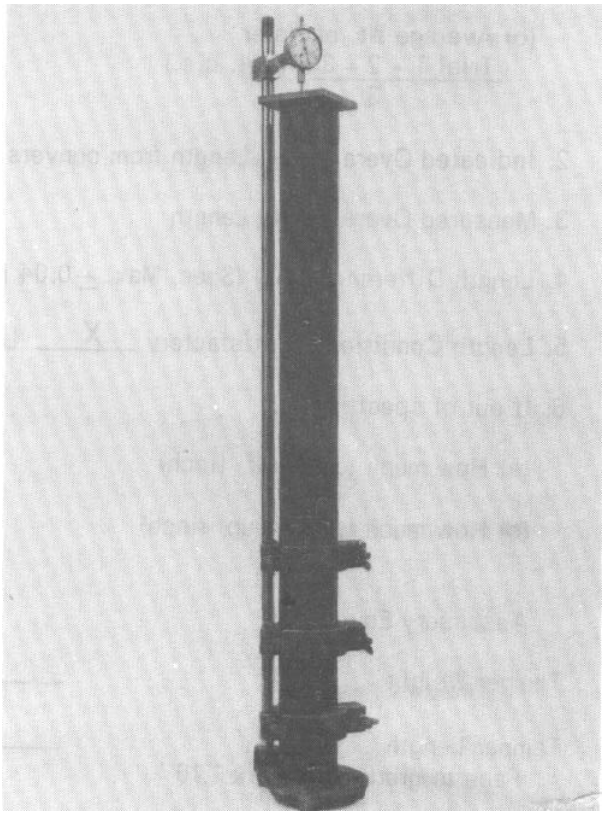

FIGURE 9

CALIFORNIA IMPACT COMPACTION MOLD CALIBRATION CONVERSION TABLE

Volume L	Mold Length mm	Volume L	Mold Length mm
1.256	916.9	1.279	911.4
1.257	916.7	1.280	911.1
1.258	916.4	1.281	910.8
1.259	916.2	1.282	910.6
1.260	915.9	1.283	910.3
1.261	915.7	1.284	910.1
1.262	915.4	1.285	909.8
1.263	915.2	1.286	909.6
1.264	914.9	1.287	909.3
1.265	914.7	1.288	909.1
1.266	914.4	1.289	908.8
1.267	914.2	1.290	908.6
1.268	913.9	1.291	908.3
1.269	913.9	1.292	908.1
1.270	913.6	1.293	907.8
1.271	913.4	1.294	907.5
1.272	913.1	1.295	907.3
1.273	912.9	1.296	907.1
1.274	912.6	1.297	906.8
1.275	912.4	1.298	906.5
1.276	912.1	1.299	906.3
1.277	911.9	1.300	906.0
1.278	911.6	1.301	905.8

NOTE:

See Figure 7. Volume in L pertains to the average of three water volume measurements of the lower 305 mm length of the mold (Item "d"). Mold length in mm refers to the finished overall length of the mold (Item "3").

The relationship between volume of the lower 305 mm of the mold and the overall length of the mold is based on a tamper length of 591.8 mm.

EXAMPLE:

If the volume of the lower 305 mm of the mold is found to be 1.256 L, 916.9 mm is the final total length of the mold to record for Item 2.

FIGURE 10

C. CHECKING ACCESSORY EQUIPMENT

The tamper must be checked when the mold is calibrated to be sure that the wearing face of the tamping foot is not badly worn from use. If the end of the tamper foot is not within a flatness of 1.27 mm and/or the edge is rounded more than 3.18 mm , it should be replaced.

The overall length of the tamper is to be adjusted to give a total mass for the tamper of 453.6 ± 4.5g. Regardless of the overall length of tamper, the distance from the tamping face to the graduation marked 10 is to be 591.8 ± 0.8 mm. The hooked bar, shown in Figure 11, is used to accurately check the required length from the tamper foot to the graduation marked "10". If the tamper foot is replaced, the new tamper must meet the given mass and length criteria.

Also check the leveling piston with calipers for adherence to length and flatness specification. The length of the piston must be 68.6 ± 0.8 mm. The diameter is adjusted to fit the tube. The top of the piston shall be within a flatness of 0.64 mm.

Check the hooked rod supplied for measuring the tamper height drop to be sure that the distance from hook to top outer edge of ring is 457.2 ± 1.6 mm.

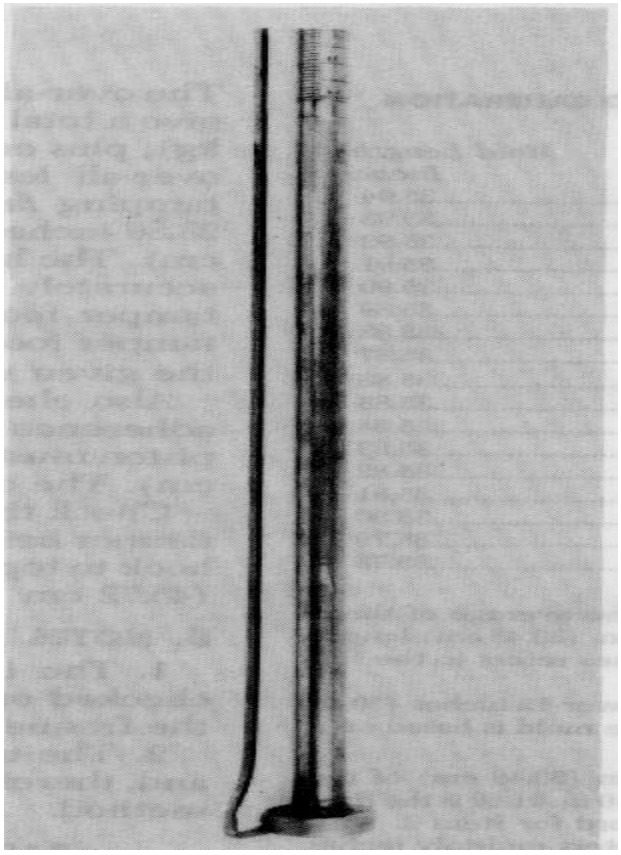

FIGURE 11

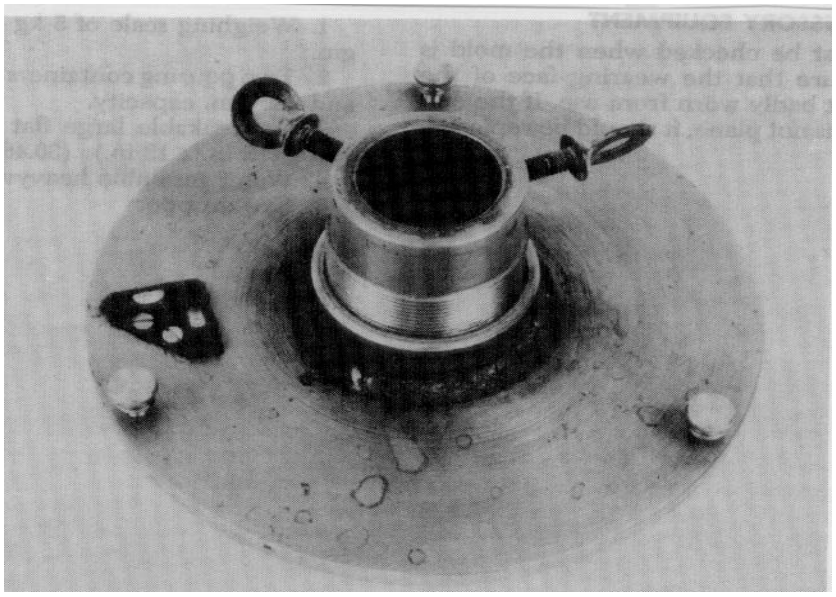

FIGURE 12

FIGURE 13

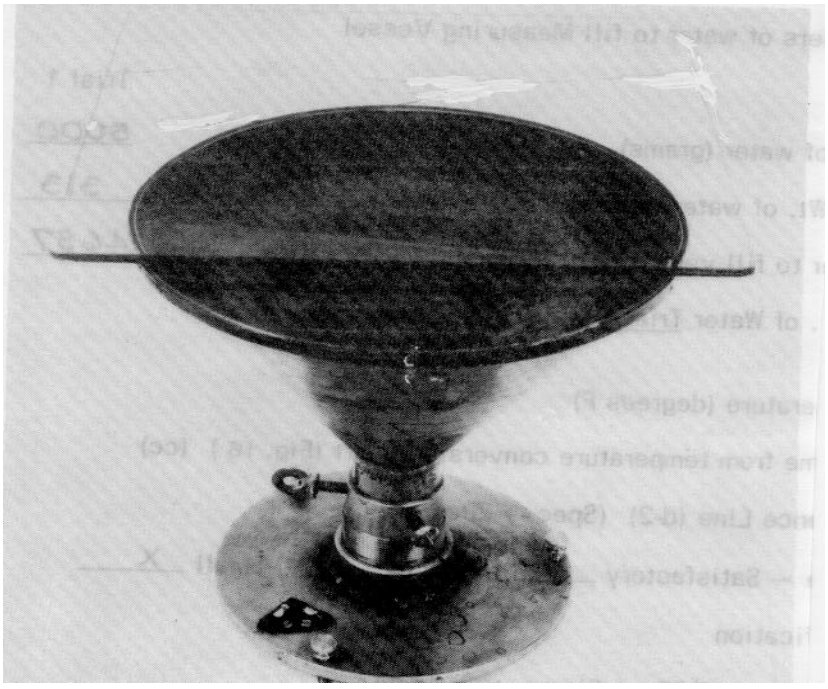

FIGURE 14

D. NOTES

1. The impact compaction apparatus should be checked once a year, or more often, depending on the frequency the equipment is used.

2. The temperature correction for water is small and, therefore, is not included in this part of the test method.

PART 2. CALIBRATION OF THE SAND VOLUME APPARATUS

A. APPARATUS

1. Measuring vessel, 4720-mL capacity

2. Sand volume cone, 4720-mL capacity

3. Weighing scale of 5-kg capacity, sensitive to 1 g

4. Two pouring containers for water: 5-L capacity and 200- mL capacity

5. Shatter resistant, large, flat, transparent nonpliable plate, 305 by 305 mm

6. Water-insoluble heavyweight grease

7. Eye dropper

8. Cone vertical-mount device (See Figure 12)

9. Thermometer capable of measuring 0 to 30°C, sensitive to 0.5°C

B. CALIBRATION OF THE SAND VOLUME CONE

1. Place the sand volume cone in the vertical-mount device inserting the orifice into the threaded collar of the device. Tighten the thumb screws on the orifice; then rotate the mounted cone clockwise until it is tight against the rubber baseplate pad. See Figure 13.

2. Level the cone using the baseplate leveling screws. Incline the baseplate slightly on one side so it is out of level.

3. Place a thin bead of grease on the cone base. Place the transparent plate on the base so it covers most of the lower inclined part of the larger cone opening. See Figure 14.

4. Fill the containers with water. Determine the mass of the water in the containers and eye dropper to the nearest gram. Record this gross initial mass on line (a) of the Calibration Record Form. See Figure 15.

5. Carefully pour the weighed water into the cone section. As the water level reaches the base, it will form a viscous seal with the plate. Continue filling until the water level has reached the edge of the plate.

6. Gently slide the plate across the pouring opening. This technique aids in determining whether the mold is completely filled with water. If, while the plate is being slid across the surface of the opening, the viscous seal of the water shows the beginning of an air bubble, stop the plate. This shows that not enough water is in the mold section; use the eye dropper or small container to add a small amount to the exposed pouring surface. Then, resume sliding the plate across the opening. If the plate is pushing an excess of water in front as it is slid across the opening, carefully remove the excess water from the opening with the eye dropper. Above all, do not spill or lose any of this water.

7. When the plate is slid completely across the opening and shows no air bubbles underneath or spilled water, determine the mass of the remaining water to the nearest gram and record on line (b) of the Calibration Record. See Figure 15. Recover water not used in the pouring in order to have an accurate calibration.

8. Then, take the difference between the initial water mass, line (a), and the residue water mass, line (b). This

difference, is also the volume of the measured section, in mL. Take an average of three pourings. Record these measurements on line (d) of the Sand Volume Apparatus Calibration Record. See Figure 15.

9. Measure the temperature of the water poured. Refer to the water temperature table for the theoretical volume in Line 2 of the Calibration Record. See Figure 16. The difference is then taken between the measured and theoretical volumes and is entered on Line 3. See Figure 15.

10. From Figure 16, obtain the cut or buildup amount. In some cases, it may not be advisable to try building up a small-volume cone. The cutting down of a large volume is feasible.

C. CALIBRATION OF THE SAND MEASURING VESSEL (HAT)

1. Fill the containers with water. Determine the mass of the water containers and eye dropper to the nearest g. Record this total initial mass on Line (a) of the Calibration Record Form. See Figure 15.

SAND VOLUME APPARATUS CALIBRATION RECORD

Date _____ District _____ Calibrated By: _____

1. Volume of water to fill measuring vessel, in mL

(a) Initial mass of water, in g	5000	5057	5180
(b) Remaining mass of water, in g	313	373	492
(c) Mass of water to fill vessel, a-b, in g	4687	4684	4688
(d) Average mass of water $\frac{\text{Trial } 1 + 2 + 3}{3}$			4686.3
(e) Water temperature, in °C			72

2. Indicated volume from Temperture Conversion Chart (Figure 16), in mL 4708.8

3. Volume difference line, d-2, in mL (Specification = Volume from Step 2 (±20 mL) -22.5

4. Vessel volume: Satisfactory_____ Large _____ Small X

5. If out of specifications,

(a) How much to remove (From Figure 16), in mm _____

(b) How much to build up (From Figure 16), in mm 0.014

FIGURE 15

2. Place the measuring vessel, also called the hat, on a stable, level surface. Set the strike-off plate on top of the measuring vessel so that it covers most of the opening. See Figure 17. Carefully pour water into the hat. As the water level comes near to the top of the hat, use the eye dropper or small container to complete the pouring.

3. Gently slide the clear plate across the pouring opening. If, while the plate is being slid across the surface of the opening, the viscous seal of the water shows an air bubble beginning, stop the plate. This shows that not enough water is in the mold section; use the eye dropper to add a few drops to the exposed pouring surface. Then, resume sliding the plate across the opening. If the plate is pushing an excess of water in front as it is slid across the opening, carefully remove the excess water from the opening with the eye dropper. Above all, do not spill or lose any of this water.

4. When the plate is slid completely across the opening and shows no air bubbles underneath or spilled water, determine the mass of the remaining water to the nearest g and record on line (b) of the Calibration Record. See Figure 15. Recover the water not used in the pouring in order to have an accurate calibration. Then, take the difference between the initial water mass and the residue water mass. This difference is the volume of the measured section, in mL. Make three pourings and record these measurements on line (c) of the Mold Calibration Record. See Figure 15. Record the average of three pourings on line (d) of Figure 15.

5. Measure the temperature of the water poured. Refer to the water temperature table for the theoretical volume in mL. See Figure 16. Enter this volume on line 2 of the Calibration Record. See Figure 15. Then take the difference between the measured and theoretical volumes, enter this value on Line 3. See Figure 15.

6. From Figure 16, obtain the cutoff for a large hat or the bore amount corresponding to the deficiency in volume of a small hat.

D. NOTE

The sand volume apparatus should be checked every year, or more often, depending on how frequently the equipment is used.

E. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCE:
California Test 216

End of Text (California Test 110 contains 14 Pages)

Temperature (°C)	Mass (g)
0.0	4718.9
0.5	4719.1
1.0	4719.2
1.5	4719.3
2.0	4719.4
2.5	4719.4
3.0	4719.5
3.5	4719.5
4.0	4719.5
4.5	4719.5
5.0	4719.5
5.5	4719.4
6.0	4719.4
6.5	4719.3
7.0	4719.2
7.5	4719.1
8.0	4718.9
8.5	4718.7
9.0	4718.5
9.5	4718.4
10.0	4718.2
10.5	4717.9
11.0	4717.7
11.5	4717.5
12.0	4717.2
12.5	4716.9
13.0	4716.7
13.5	4716.4
14.0	4716.1
14.5	4715.8
15.0	4715.4
15.5	4715.5
16.0	4714.7

Temperature (°C)	Mass (g)
16.5	4714.2
17.0	4713.8
17.5	4713.4
18.0	4713.0
18.5	4712.5
19.0	4712.0
19.5	4711.7
20.0	4711.1
20.5	4710.6
21.0	4710.1
21.5	4709.6
22.0	4709.0
22.5	4708.5
23.0	4708.0
23.5	4707.4
24.0	4706.8
24.5	4706.4
25.0	4705.8
25.5	4705.2
26.0	4704.4
26.5	4704.1
27.0	4702.8
27.5	4702.4
28.0	4702.0
28.5	4701.6
29.0	4701.0
29.5	4700.3
30.0	4699.9
30.5	4699.4
31.0	4698.7
31.5	4697.5
32.0	4697.3
32.5	4696.9

Example calculation for cone or top hat:

Assume a water temperature of 22°C

a. Gross initial mass of water (g) 5,200.0

b. Gross final mass of water (g) 513.7

c. Net mass of water (a - b) (g) 4,686.3

d. Mass of water in the test vessel , at 22°C(g) 4,708.8

e. Difference in mass of (c - d) (g) 22.5
Increase volume of top hat or cone by 22.5 g

FIGURE 16 - WATER TEMPERATURE CORRECTIONS (TEST VESSELS)

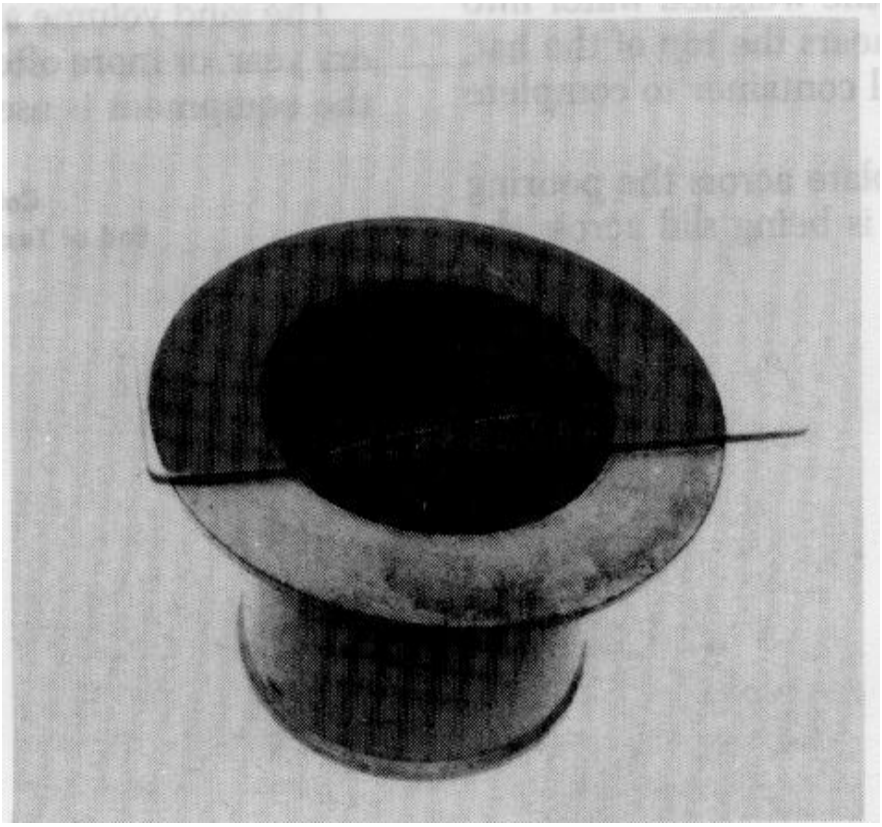

FIGURE 17 - MEASURING VESSEL (HAT) WITH STRIKE-OFF PLATE